The invention relates to a valve drive assembly for an internal combustion engine. The aim of the invention is to improve the assembly in such a manner that a stationary cam can be reliably connected to a cam that is rotatably mounted on the camshaft and to avoid malfunctions. For this purpose, a groove-type guide is arranged in the area of the base circle of the cam which is rotatably mounted on the camshaft. A pilot locking plunger is mounted in a blind bore of the base circle of the cam that is connected to the camshaft so as to rotate with it. The plunger can be displaced in a controlled manner and can be engaged with the guide disengaged therefrom. The groove-type guide in which the pilot locking plunger engages extends in the base circle of the rotatably mounted cam by approximately 180°.
The invention relates to a valve drive assembly for internal combustion engines with the features indicated in the preamble of claim 1.

From DE 42 28 796 A1, a variable valve drive for internal combustion engines is already known, wherein the gas-exchange valve is operated with different cam contours for adjustment of the valve lift and/or of the valve control times. For this purpose, one cam is mounted rotatably on the camshaft, and the other cam is mounted rigidly on the camshaft. In the full-load range of the internal combustion engine, an electronic controller injects pressurized oil into a hydraulic chamber of the fixed cam, by way of an isolating valve, and thus displaces corresponding plungers, whereby the fixed cam is coupled, by means of shape fit, with the cam mounted rotatably on the camshaft, by engaging the plunger into a bore disposed in the cam region of the rotatably mounted cam. The cam coupled by means of shape fit actuates the respective gas-exchange valves with relatively large lift, by way of a tappet. In the partial-load range, with the oil pressure disconnected, the two cams coupled with one another become separated. The fixed cam with small lift actuates the tappet, while the cam mounted rotatably on the camshaft is uncoupled and the camshaft rotates freely in this cam. To ensure that the displaceable plunger can engage into the corresponding bore in the rotatable cam during coupling of the two cams, an entry ramp is disposed in front of the bore in the cam region.

A disadvantage of this solution is the small range for the interlocking plunger to engage into the bore of the rotatably mounted cam, during connection of the two cams by means of shape fit. In this connection, malfunctions cannot be precluded, especially in the case of torques that alternate in their direction of rotation.

The invention is based on the task of creating a valve drive assembly for an internal combustion engine of the type in question, with which secure connection of a fixed cam with a cam mounted rotatably on the camshaft is achieved, and with which malfunctions are avoided.

This task is accomplished, according to the invention, by means of the characterizing features of claim 1.

According to the invention, in a variable valve drive for an internal combustion engine, with at least two cams disposed on a camshaft and provided with different profiles, which cams selectively actuate at least one gas-exchange valve, and wherein one cam is connected to the camshaft so as to rotate with it, and the other cam is mounted rotatably on the camshaft and can be connected, by means of shape fit, to the cam disposed on the camshaft so as to rotate with it, by way of a controllable locking plunger, a groove-like guide is disposed in the region of the base circle of the cam mounted rotatably on the camshaft, with which guide a pilot locking plunger, which is mounted so as to be controllably displaced in a blind-hole bore of the base circle of the cam connected to the camshaft so as to rotate with it, can be engaged and from which guide it can be disengaged. The groove-like guide, into which the pilot locking plunger can engage, extends by approximately 180° in the base circle of the rotatably mounted cam.

The advantage of the solution according to the invention consists in the fact that, during the operation of interlocking of the two cams with one another, a range of approximately 180° is available, in which a pilot locking plunger can be inserted without problems. In this way, faulty switching operations are very largely precluded. After insertion of the pilot locking plunger, the rotatable cam is carried along by the pilot locking plunger, so that, by virtue of the equal speeds of the two cams, the main locking plunger can then engage into the corresponding bore in the rotatably mounted cam, without problems, and ensures torque transmission during running operations that alternate in their direction.

The invention will be described in greater detail hereinafter, on the basis of exemplary embodiments, with reference to drawings. The associated drawings show:

FIG. 1: A schematic diagram of the valve drive according to the invention, in section, with interlocked cams,
FIG. 2: A section A-A according to FIG. 1,
FIG. 3: The main locking plunger as a detail X-X according to FIG. 1, but in the de-interlocked position, and
FIG. 4: The pilot locking plunger offset by 90°, as a detail Y-Y according to FIG. 1, but in de-interlocked position.
FIG. 1 illustrates a longitudinal section of the valve drive according to the invention, wherein a fixed cam 2 and a cam 3 mounted rotatably on the camshaft 1 are disposed next to one another on a camshaft 1. Both cams 2 and 3 have the same base-circle diameter 14 and 15. The rotatably mounted cam 3 possesses a larger profile height than the cam 2, for maximum valve lift during full-load operation of the internal combustion engine. The cam 2 is designed for a small lift or for zero lift, for partial-load operation of the internal combustion engine.

When a cam 3 is de-interlocked from the cam 2, only the cam 2 acts on a roller-type cam follower or tappet, not shown, which actuates one or more gas-exchange valves of a cylinder of the internal combustion engine. In this condition, the camshaft 1 rotates freely in the cam 3. When the cams are interlocked, only the cam 3 acts on a roller-type cam follower or tappet, not shown, which actuates one or more gas-exchange valves of a cylinder of the internal combustion engine. By virtue of the smaller profile height of the cam 2, it does not become engaged with the roller type cam follower or tappet when it is in the coupled condition.

According to the invention, interlocking of the cam 2 disposed rigidly on the camshaft 1 with the cam 3 mounted rotatably on the camshaft 1 takes place by means of a pilot locking plunger 16 and a main locking plunger 6. The cam 3 can be coupled with and uncoupled from the cam 2 by way of the pilot locking plunger 16 and the main locking plunger 6.

The pilot locking plunger 16 illustrated in FIG. 4 in the de-interlocked position is mounted so as to be displaceable in a blind-hole bore 17, which is disposed in the region of the base circle 14 of the cam 2, preferably in its edge region, and thus at approximately 90° relative to the main locking plunger 6. A groove-like guide 8, with which and from which the controllably displaceable pilot locking plunger 16 can be engaged and disengaged, is disposed in the region of the base circle 15 of the cam 3 mounted rotatably on the camshaft 1. The groove-like guide extends by approximately 180° in the region of the base circle 15 of the cam 3.

The displacement of the pilot locking plunger 16 in the direction of the groove-like guide 8 takes place in a manner so as to be regulated, by means of oil pressure of the pressurized circulating lubricating-oil system of the internal combustion engine. For this purpose, a supply duct 22, which is in communication with a bore 12 running in the longitudi-
nal direction of the camshaft 1, opens into the blind-hole bore 17. The blind-hole bore 17 is therefore in communication with a control duct 11b disposed in a bearing 5 of the camshaft 1, by way of a radial duct branched off from the bore 12. The pressurized-oil supply to the control ducts 11a and 11b takes place by way of isolating valves that can be regulated, not shown. For this purpose, the connectable and disconnectable control duct 11a serves to de-interlock the cam 3, and the connectable and disconnectable control duct 11b serves to interlock the cam 3. A spring 18, which acts against the oil pressure acting to displace the pilot locking plunger 16 in the direction of the groove-like guide 8, is disposed at the bottom of the pilot locking plunger 16.

[0018] The main locking plunger 6 illustrated in FIG. 3 in the de-interlocked position is mounted so as to be displaceable in a blind-hole bore 20 disposed in the region of the cam 2. The controlled displacement of the main locking plunger 6 in the direction of the cam 3 takes place by means of a spring 7 disposed between the bottom of the main locking plunger 6 and the bottom of the blind-hole bore 20, and also by means of the oil pressure of the pressurized circulating lubricating-oil system of the internal combustion engine, which pressure can be regulated. For this purpose, the blind-hole bore 20 in the region of the cam 2 is in communication with a control duct 11b disposed in the bearing 5, by way of a radial duct 21, an axial duct 12 disposed in the camshaft 1, and a further radial duct disposed in the camshaft 1.

[0019] A blind-hole bore 13, in which a sealing plunger 19 is disposed so as to be displaceable, is disposed in the region of the cam 3, pointing in the direction of the cam 2. The blind-hole bore 13 is in communication with a control duct 11a of the controllable pressurized-oil supply, by way of a radial bore 10 disposed in the camshaft 1, the axial duct 4 disposed in the camshaft 1, and a further radial bore 9 disposed in the camshaft 1.

[0020] The principle of action of the valve drive for internal combustion engines, according to the invention, is the following:

[0021] During full-load operation, the cam 3 provided with the larger cam profile is engaged with the gas-exchange valve by way, for example, of a cam follower. In the process, the cam 3 mounted rotatably on the camshaft 1 is connected, by means of shape fit, with the cam 2 disposed on the camshaft 1 so as to rotate with it, as illustrated in FIG. 1. A corresponding oil pressure bears on the bottom of the pilot locking plunger 16, by way of the supply duct 22, which pressure has displaced the pilot locking plunger 16 into the groove-like guide 8 of the cam 3. In an interlocked position of the cam 3 with the cam 2, the pilot locking plunger 16 bears on the outer boundary of the guide 8, as viewed in the direction of rotation of the camshaft 1. The main locking plunger 6 is partly displaced into the blind-hole bore 13 of the cam 3, by virtue of the oil pressure acting on the main locking plunger 6, so that shape fit contact between the cam 3 and the cam 2 exists by way of the main locking plunger 6.

[0022] During partial-load operation of the internal combustion engine, with a small valve lift or a zero lift, the connection between the cam 3 and the cam 2 is separated. In the process, the oil pressure acting on the pilot locking plunger 16 and on the main locking plunger 6 by way of the radial duct 21 is disconnected by means of a control device, which can be regulated, so that these plungers are depressurized. The pilot locking plunger 16 is retracted, by means of the spring 18, into the blind-hole bore 17. At the same time, pressurized oil is admitted to the blind-hole bore 13, by way of the radial bore 10. The oil pressure displaces the sealing plunger 19, and thus the main locking plunger 6, until the latter is located completely in the blind-hole bore 20 of the cam 2. The cam 3 is therefore de-interlocked, and the cam 3 is no longer driven indirectly by the camshaft 1.

[0023] If the internal combustion engine is run in full-load operation once again, coupling of the cam 3 with the cam 2 takes place once again, as a function of the engine-specific parameters. Pressurized oil is supplied to the blind-hole bore 17 by way of a control duct 11b and the supply duct 22, and to the blind-hole bore 20 by way of the radial duct 21. The pilot locking plunger 16 is displaced, by means of the oil pressure, in the direction of the cam 3, and can be inserted into the groove-like guide 8. Secure insertion of the pilot locking plunger 16 during the interlocking operation is achieved by means of the fact that the guide 8 extends over approximately 180° in the region of the base circle 15. After the pilot locking plunger 16 has been inserted into the guide 8, the cam 3 is carried along by means of the pilot locking plunger 16. Because of the force of the spring 7 and the oil pressure bearing on the main locking plunger 6, the main locking plunger 6 is displaced partly into the blind-hole bore 13 during axial alignment of the blind-hole bore 20 and the blind-hole bore 13. In this way, the interlocking process is completed and the cam 3 is active on the gas-exchange valve.

LIST OF REFERENCE SYMBOLS USED

[0024] 1 Camshaft
[0025] 2 Cam
[0026] 3 Cam
[0027] 4 Duct
[0028] 5 Bearing
[0029] 6 Main locking plunger
[0030] 7 Spring
[0031] 8 Guide
[0032] 9 Radial bore
[0033] 10 Radial bore
[0034] 11a Control duct, connectable and disconnectable, for de-interlocking the cam 3
[0035] 11b Control duct, connectable and disconnectable, for interlocking the cam 3
[0036] 11b bore
[0037] 12 Blind-hole bore
[0038] 13 Base circle of the cam 2
[0039] 14 Base circle of the cam 3
[0040] 15 Pilot locking plunger
[0041] 16 Blind-hole bore
[0042] 17 Spring
[0043] 18 Sealing plunger
[0044] 19 Blind-hole bore
[0045] 20 Radial duct
[0046] 21 Supply duct

1: Valve drive assembly for an internal combustion engine, with at least two cams disposed on a camshaft and provided with different profiles, which cams selectively actuate at least one gas-exchange valve, and wherein one cam is connected to the camshaft so as to rotate with it, and the other cam is mounted rotatably on the camshaft and can be connected, by means of shape fit, to the cam disposed on the camshaft so as to rotate with it, by way of a controllable locking plunger, wherein a groove-like guide (8) is disposed in the region of the base circle (15) of the cam (3) mounted rotatably on the
camshaft (1), with which guide a pilot locking plunger (16), which is mounted so as to be controllably displaced in a blind-hole bore (17) of the base circle (14) of the cam (2) connected to the camshaft (1) so as to rotate with it, can be engaged and from which guide it can be disengaged.

2: Valve drive assembly according to claim 1, wherein the groove-like guide (8) extends over approximately 180° in the region of the base circle (15) of the cam (3).

3: Valve drive assembly according to claim 1, wherein the blind-hole bore (17) is in communication with a controllable pressurized-oil supply for displacement of the pilot locking plunger (16) in the direction of the groove-like guide (8).

4: Valve drive assembly according to claim 1, wherein a spring (18) is disposed on the bottom of the pilot locking plunger (16), which spring acts against the oil pressure acting to displace the pilot locking plunger (16) in the direction of the groove-like guide (8), and displaces the pilot locking plunger (16) in the direction of the bottom of the blind-hole bore (17) upon disconnection of the oil pressure for displacing the pilot locking plunger (16) in the direction of the groove-like guide (8), and the connection of the cam (3) with the cam (2) is de-interlocked by means of the pilot locking plunger (16).

5: Valve drive assembly according to claim 1, wherein a blind-hole bore (20) is disposed in the region of the cam (2), in which bore a displaceable main locking plunger (6) is controllably mounted, which plunger can be engaged with and disengaged from a blind-hole bore (13) disposed in the region of the cam (3).

6: Valve drive assembly according to claim 1, wherein the blind-hole bore (20) in the cam (2) and the blind-hole bore (13) in the cam (3) are in communication with a controllable pressurized-oil supply for displacement of the main locking plunger (6).

7: Valve drive assembly according to claim 1, wherein a spring (7) is disposed between the bottom of the main locking plunger (6) and the bottom of the blind-hole bore (20) in the cam (2).

8: Valve drive assembly according to claim 1, wherein a sealing plunger (19) is disposed in the blind-hole bore (13).

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